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e-learning system with the BBS/Chatting using mathematical expressions and mark/annotation in Web based contents

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Abstract: An e-learning system with a variety of communication media between lecturers and students is proposed. The proposed system allows use mathematical expressions during the questions and answers (Q/A) together with marking in the e-learning contents through Bulletin Board System: BBS and chatting (BBS/Chatting). Through the comparative studies between with and without the functions of mathematical expressions and mark/annotations through BBS/Chatting with experiments with 10 students, it is found that effectiveness of the proposed system.

Key words: e-learning, bulletin board system, chatting, MathML, mark/annotation in Web. Based contents

1. Introduction

e-learning is getting more popular in the world. Fundamental system is developed from Web Based Training: WBT in the early 1980s. There are two types of e-learning, on-demand and synchronous e-learning systems. There are two major standard systems, Shareable Content Object Reference Model: SCORM[1] and ISO/IEC JTC1 SC36 of Information Technology for Learning, Education and Training: ITLET[2] based systems Non-Profitable Organization: NPO of e-learning consortium in Japan adopted SCORM. They developed Japanese version of SCORM version 1.3. Advanced Distributed Learning Initiative: ADL that was established for promoting standardization of learning systems in 1997 developed SCORM standard for interoperable learning management system and e-learning contents [3]. e-learning system consists e-learning contents, execute engine and software tools. There are so many types of media assets of the e-learning contents such as 2D, 3D graphics, audio and video. As for the authoring tools, HTML, XML tags, FLASH of time line, Authorware for icon and Toolbook, Director of hyperlink are widely used. There also are so many content describe language, Java, Javascript, ActionScript, XSL, and Simulations. Meanwhile, e-learning content XML that consists of content and semantic structure with XSL and metadata are available for representing the data structure. Web browser, XML, Java and Plug-in of FLASH, PDF, Scalable Vector Graphics: SVG as well as RealOne and Windows Media Player: WMP for streaming are well known as the execute engine.

One of the problems of the widely available existing e-learning systems, in particular for science subjects, is less of communication capabilities on the BBS/Chatting between lecturers and students [4]. The existing e-learning system allows only alphanumeric characters of text for the BBS/Chatting so that it is not so easy to communicate each other during Q/A processes. Lecturers and students would like to use mathematical expressions together with marking in the e-learning contents during their communications through BBS/Chatting because students would like to ask about equations included in the e-learning content frequently. An e-learning system is proposed in order to provide more flexibility for the communications through BBS/Chatting, in particular for scientific subjects. Also lecturers and students would like to use marks [5] and annotations [6] in the Web based e-learning contents as they ask questions through BBS/Chatting, in particular for scientific subjects. This is referred to "marking" function hereafter.

The proposed system is described at first followed by the some specific features of the proposed system, mathematical expressions and mark/annotations in the e-learning contents during communications through BBS/Chatting.

2. Proposed system

2.1 System configuration

The proposed system is a synchronous type of Web

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based e-learning system and is based on a Client-Server system configuration as is illustrated in Fig.1. In principle, lecturers provide e-learning contents such as slides, streaming videos, etc. to students together with BBS/Chatting communications in a synchronous basis. All the contents together with an authoring tool are written by the PHP Version 4.3.8. Also Learning Management System: LMS is included in the server. Because the server uses Apache Version 1.3.31 so that learning related information such as client IP address, subjects selected by students, score of achievement test, elapsed time and so on can be referred by looking at the access logs. Students may access to the e-learning contents after the authentication by the server. Lecturers may access to the LMS to check the learning status of each student after the authentication. Both lecturers and students may communicate each other through BBS/Chatting.

One of the examples of the Web browser (Internet Explore ver.6.0) image in accordance with the authoring tool is shown in Fig.2.

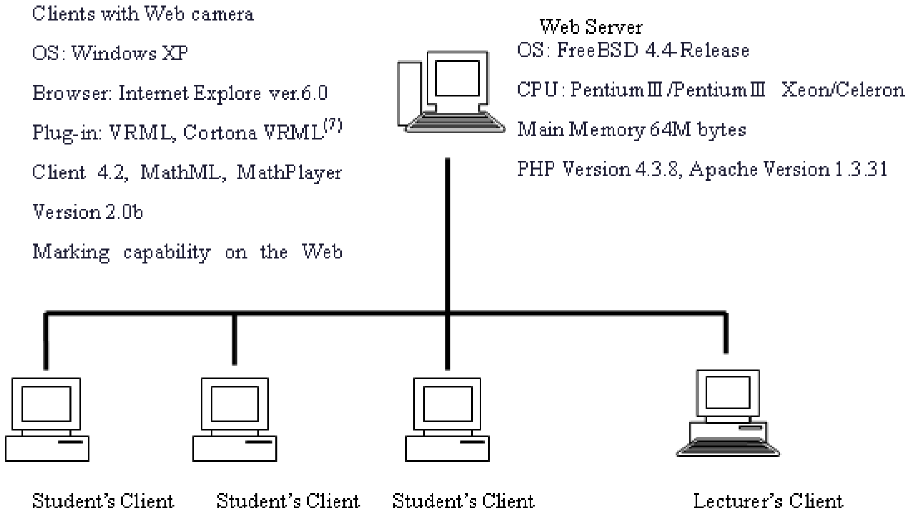

Fig.1 The proposed client-server basis e-learning system architecture.

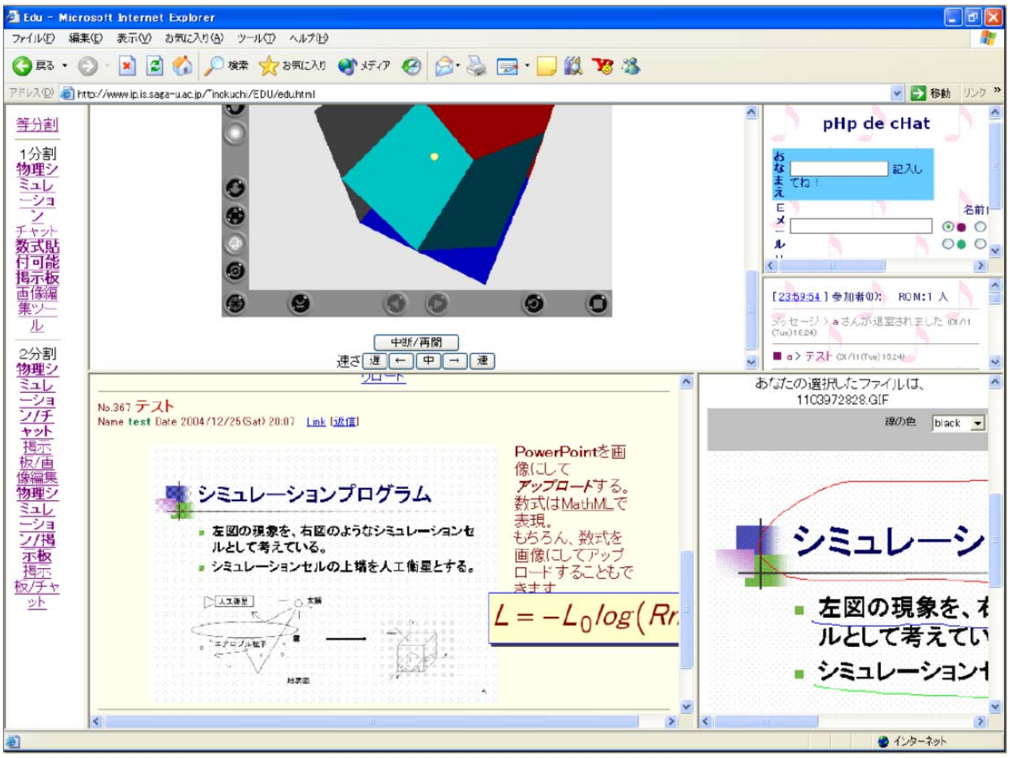

Fig.2 Example of the Web browser images of the proposed e-learning system (Partitioning can be set freely. In the figure, web browser window is divided into four partitions, physical simulation, PHP based chatting, mathematical expression available BBS and Power Point slide with mark/annotations).

There are four major windows, (1) Lecturer's video streaming, (2) e-learning content in the form of slides, Power Point files, (3) BBS/Chatting, and (4) Lecture contents and sequence (Syllabus) in this Web browser. During the practise, students may refer to the supplemental contents of video streaming of the template as well as students' real time moving picture streaming of the lecture and/or student faces for improvement of their pronunciations by comparing both of the streaming.

2.2 Procedure of the learning with the proposed system

The data and information communicated between lecturers and students and the procedure of the learning process with the proposed e-learning system is shown in Fig.3. Lecturers have to be authenticated then they can take look at the students learning status, score of the achievement tests, etc. Also students have to be authenticated then they can access to the e-learning contents. After that students begin learning with the contents provided by the lecturers through the server. Students may ask questions through BBS/Chatting to the lectures in concern. Although the existing e-learning systems provide the BBS/Chatting with alphanumeric character only, the proposed system allows usage of the mathematical expressions as well as mark/annotations through BBS/Chatting as is shown in Fig.3.

***Client* Lecture ⟺ *Server* ⟺ *Client* Student**

→(1)Authentication
Referring the learning management system and access logs
(2)Authentication ←
(3)Access to the e-learning contents, learning sequence control status, syllabus, Power Point slide files, streaming videos, etc. ←
→(4)Questions and answerers, Q/A through BBS/Chatting ←
→(4.1)Mathematical expressions during Q/A ←
→(4.2)Mark/annotations during Q/A ←

Fig.3 The data and information transferred between lecturers and students and the learning procedure of the proposed e-learning system.

An example of the e-learning content for the subject of satellite remote sensing principle with simulations is shown in Fig.4. The table situated at the upper half of the Fig.4 shows simulation parameters. Students have to select all the required parameters. Then a photon is appeared from the top of the computation cell of Monte Carlo simulation which is illustrated with VRML automation.

When the simulation is started with the designated parameters, the coordinate of the photon is recorded in a file together with the time line. With referring to the time line, VRML automation makes animated photon trajectory. In the bottom half of the Fig.4 shows an example of the VRML animation. Photon injected from the top of the cell travels in the cell of the atmosphere then scattered and absorbed when the photon meets molecules and or aerosol particles. Then the photon is reflected on the ground and travels again in the atmosphere.

Such this process flow is shown in Fig.5. Starting from the parameter setting web page, Monte Carlo simulation program in C language is executed, then the coordinate of the photon is recorded in a location file together with time line. After that photon movement animation is displayed onto web browser with VRML automation together with the some text for annotations.

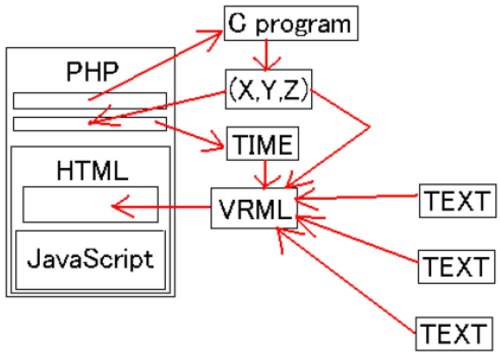

Fig.5 Language used for the Monte Carlo simulation for the subject of the principle of remote sensing.

2.3 Specific features of the proposed system

2.3.1 Mathematical expressions

For communications between lecturers and students, BBS/Chatting is useful. The proposed system makes not only alphanumeric characters but also mathematical expressions available. In order for that, Mathematical Markup Language, MathML with MathPlayer Version 2.0b [(7)] (pug-in in advance) is used. Only thing lecturers and students have to do is key-in the equations in concern in accordance with TeX style of expression, then MathML tool converts from TeX style to JPEG formatted style of the equation and display it onto Web browser.

Fig.6 shows Web browser image of BBS/Chatting of the proposed system. When lecturers and students select BBS/Chatting function, top half of Fig.6 appears. If they download the e-learning content (view graph of the illustrative explanation of satellite remote sensing principle in this case) in a prior basis, then they have the bottom half of Fig.6 is attached. In advance, Math/ML is plugged-in to the web browser so that only thing they have to do is to select the function of Math/ML from the plug-in menu bar. If they key-in LaTex based mathematical expression included questions and answers, then they will get the equation at the designated location, anywhere in the web browser window that is shown at the middle of the bottom half of Fig.5.

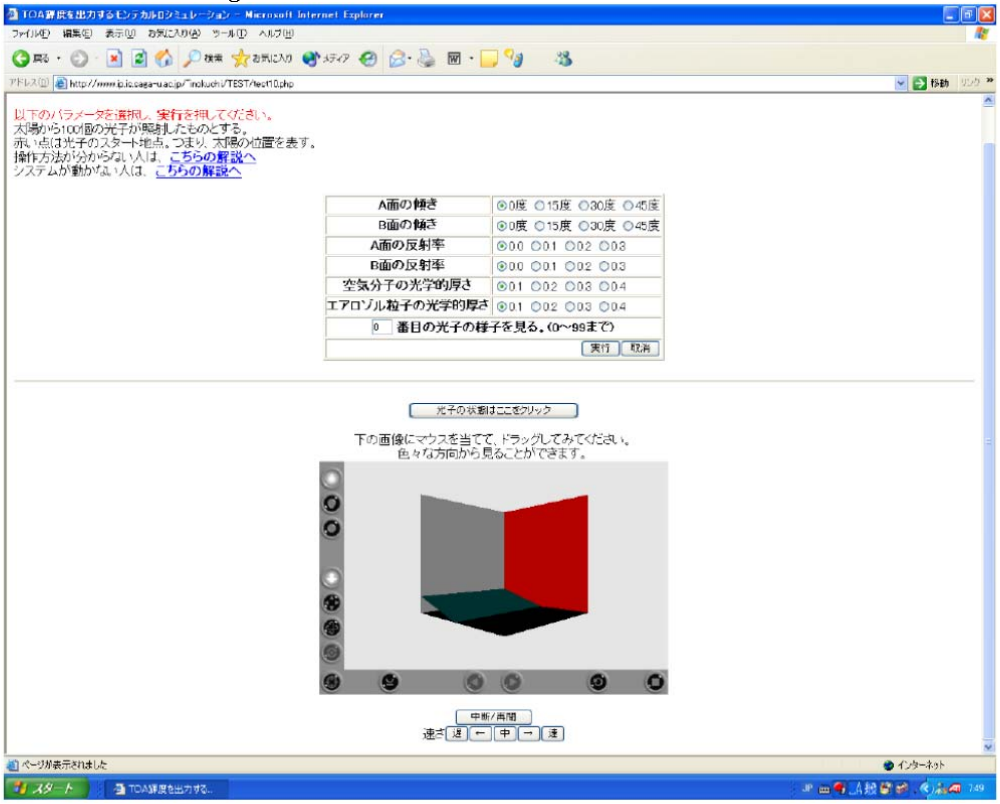

Fig.4 An example of the e-learning content for the subject of satellite remote sensing principle with simulations.

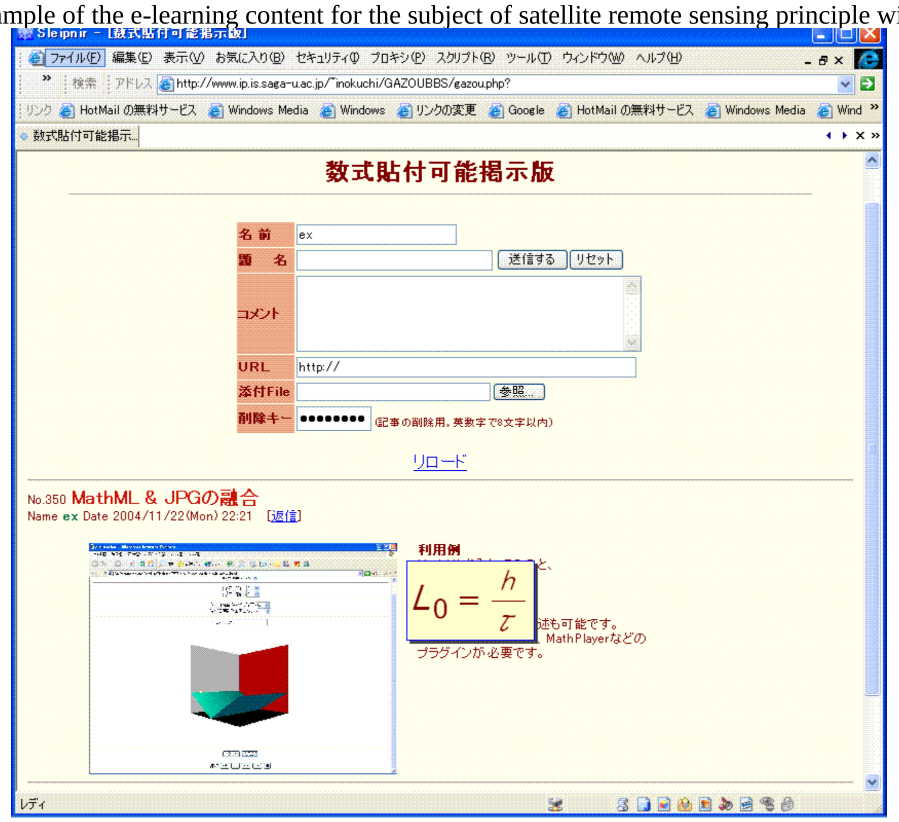

Fig.6 Once equations are up-loaded from clients and/or server to the server, and then all the clients can display the equations with MathML (Plug-in MathPlayer).

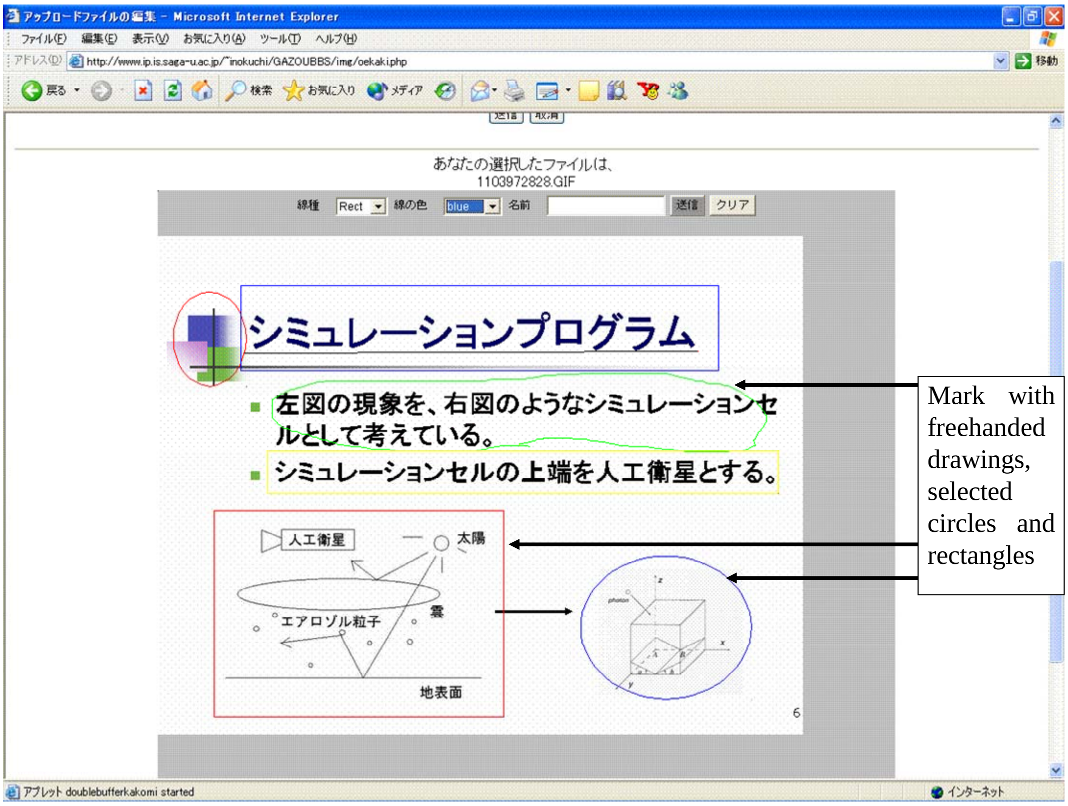

Fig.7 An example of the marks and annotations in the contents for emphasizing the points of the Q /A.

2.2.2 Mark/annotation in the slides as well as any of e-learning contents

Another specific feature of the proposed system is marking in the slides. Both lecturers and students would like to use marks (circle, ellipsoid, square, rectangle, free handed lines, etc. with the designated colours) and annotations in the e-learning contents of slides during communications through BBS/Chatting to enhance the most significant points. Such this Mark/Annotation function is already included in the current version of Power Point software. The proposed system allows Mark/Annotation on not only power point slides but also any of the e-learning contents. As is shown in Fig.7, .it is possible with the proposed system. Lecturers and/or students download a portion of the slides during the communications in advance. If lecturers and/or students choose the specific mark/annotation with colour in the communications that are provided by the client, the selected mark/annotation can be displayed on the arbitrary location in the slides and the other e-learning contents. After that lecturers and/or students upload the file to the server, the counter part can refer the mark/annotation in the slides on the Web browser in the BBS/Chatting bullet preserving the original contents.

2.2.3 Other features

Not only mathematical expression and marking functionality during communications but also voice and video streaming are also available in the BBS/Chatting.

2.2.4 Technology for the proposed system

Table 1 summarizes the technology used for instructional design, media design and programming language of the proposed system. The technology can be divided into five categories, (1) Content creation software tool, (2) Content describe language, (3) Execute engine, (4) BBS/Chatting related technology and (5) Learning Management System related technology [9].

3. Experiments

3.1 Comparative study

In order to evaluate effectiveness of the proposed system, a comparative study between with and without mathematical expressions and marking functionality in the slides during communications through BBS/Chatting is made with 10 of students who are not familiar with the subject of satellite remote sensing. 10 students use the same e-learning contents. Firstly, students access to the e-learning content and learn about the principles of satellite remote sensing with 20 pages of slides described by Power Point. In this stage, Q/A are always available through BBS and/or chatting with the different capabilities for the aforementioned two groups.

Table 1 Technology for the proposed system

Content creation tool	Power Point Word LaTeX PHP
Content Describe language	Java JavaScript HTML: GIF XML: XSL Streaming: Audio Video
Execute Engine	Web browser: Internet Explore XML: XSL Plug-in: MathML with MathPlayer Streaming: Windows Media Player
BBS/Chatting	XML: MathML Plug-in: MathPlayer CGI script JavaScript
Learning Management System (LMS)	Apache Access for content and LMS related database

During the learning process, the students may take a look at the slides freely. Sixteen of students and one lecture out of four of lectures and students used the marking function. Also two students and one lecturer used mathematical expressions during the BBS/Chatting. In advance to use the proposed e-learning system, they took a look at all of the functions containing the system to getting start their learning. Everybody who used the function said that the functions are very useful and Q/A are getting more comprehensive.

One of the examples of the Web Test is shown in Fig.8. Students have to choose one of the candidates of the answer to the question with the corresponding radio-bottom.

3.2Experimental Results

The results of the achievement test are shown in Fig.9. In the figure, black circle shows the time required for BBS/Chatting and the score for the existing e-learning system while red circle shows the results for the proposed e-learning system. The mean and standard deviation (Std.) of the time required for BBS/Chatting and marking and the score are summarized in Table 2.

Table 2 The mean and standard deviation (Std.) of the time required for BBS/Chatting and the score for both of the proposed and existing systems.

System		Mean	Std.
Proposed	Time(sec)	230.05	71.58
	Score	71.58	8.98
Existing	Time(sec)	227.15	70.39
	Score	61.25	11.68

The proposed system requires a little longer time than the existing system for BBS/Chatting and marking because equations have to be input for the proposed system and also put a mark in the view graphs. Meanwhile, the score for the proposed system is improved 10.33 points (100 points in maximum) in comparison to the existing system. The confidence intervals at the confidence level of 95%, $C.I._{95}$ is expressed as follows,

$$C.I._{95} = Mean \pm 1.960 \frac{Std.}{\sqrt{n}} \qquad (1)$$

where n denotes the number of samples (20 in this case). $C.I._{95}$ for the score of the proposed system is 3.94 while that of the existing system is 5.12. Both of $C.I._{95}$ is not overlapped so that the difference of the scores between the proposed and the existing systems is significant with the confidence level at 95%. It is concluded that the proposed system is effective for comprehension of the e-learning contents by Q/A with mathematical expressions and with marks in the view graphs rather than the existing system.

The examples of Q/A through BBS/Chatting with mathematical expressions is as follows,

Q: Why the particle solar light hit can be determined as follows?

$$\begin{aligned} Rnd &\le \frac{\tau_{mol}}{\tau} \Rightarrow molecule \\ Rnd &\ge \frac{\tau_{mol}}{\tau} \Rightarrow aerosol \end{aligned} \qquad (2)$$

A: Because $\tau \approx \tau_{mol} \oplus \tau_{aerosol}$ and Rnd denotes the random number which rages from 0 to 1 so that solar light hit molecule or aerosol particle depending upon the probability.

Also the example of the marks in the view graphs is shown in Fig.4. In this case,

Q: In the Monte-Carlo simulation program, the atmospheric shell is assumed as is shown in right figure marked with blue circle. What is going on the radiation transfer in the real world of the atmosphere marked with red rectangle?

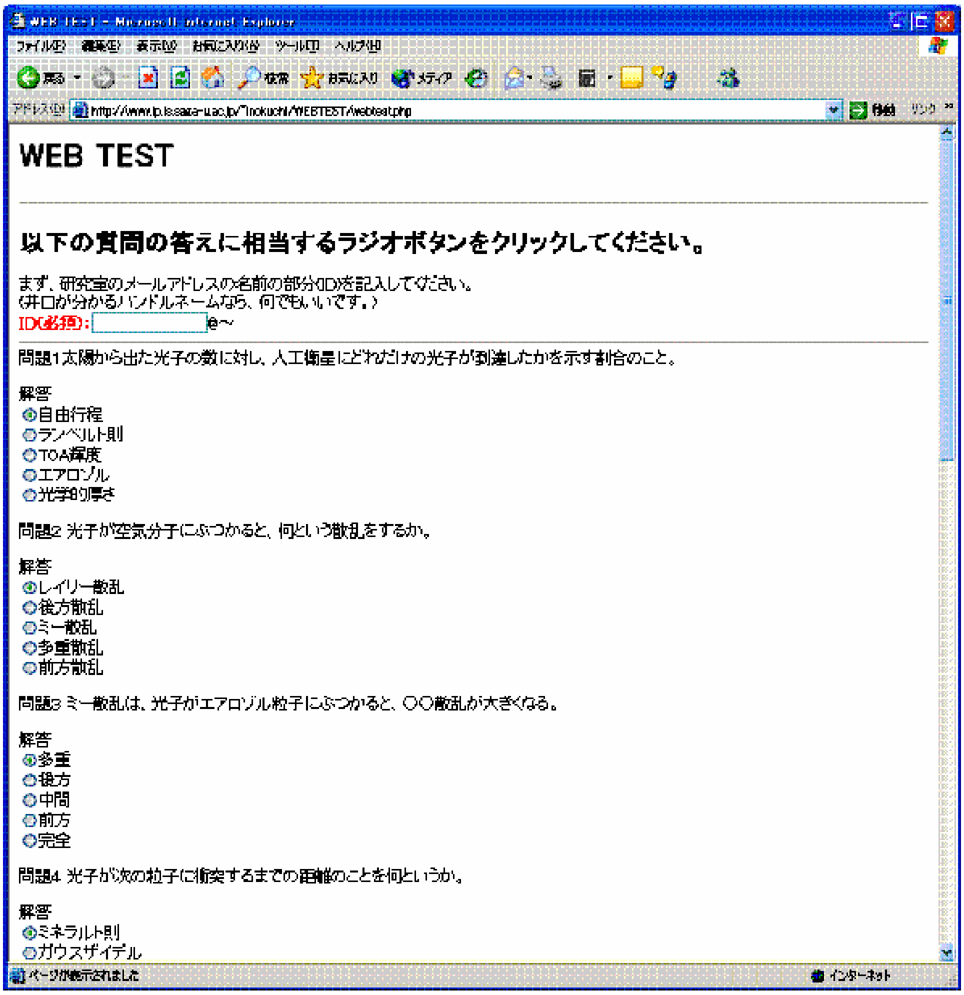

Fig.8 Example of Web (Achievement) Test: Students have to choose one of the candidates of the answer to the question with the corresponding radio-bottom (20 of questions are included in the test).

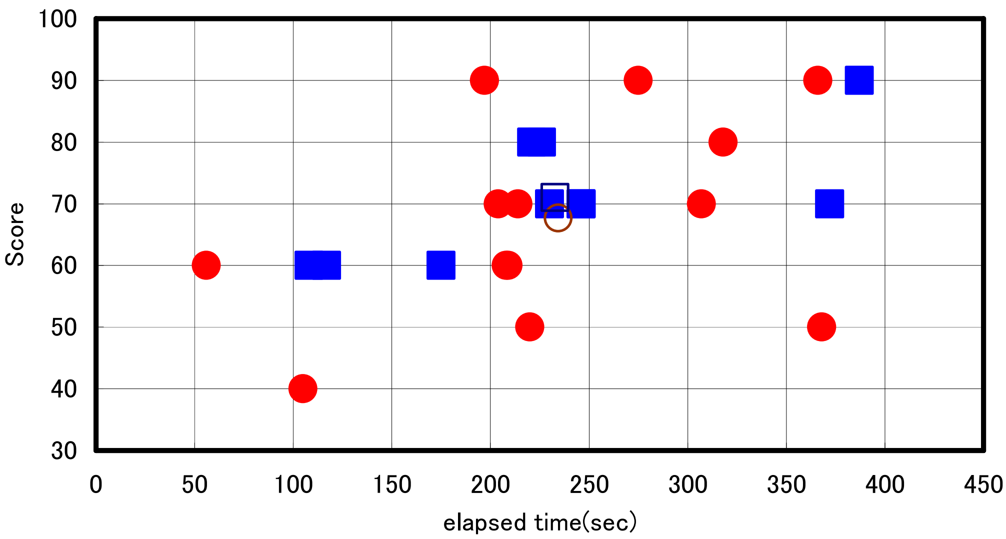

Fig.9 The results from the achievement test: with(square)/without(circle) mathematical expressions and mark/annotations in their communications, BBS/Chatting.

A: Particles in the real world of the atmosphere are cloud, aerosol, and molecule. Molecule includes nitrogen, excision, argon, carbon di-oxide, ozone, etc. as well as water vapor. Anyhow, direct solar light hit one of those particles and reflected at the surface when the solar light reached to the ground. The reflected solar light with the specified slope and reflectance characteristics such as reflectance as well as Lambertian or Mineratian surfaces is going up as an up-welling light. Only the up-welling reflected solar light and scattered light in the atmosphere reached at the top of the atmosphere within the solid angle of the satellite based instrument are effective to the at sensor radiance.

Such these Q/A can be done with mathematical expression of radiative transfer equations and marked sentences, figures and tables in the view graphs, e-learning contents. Otherwise Q/A becomes incomprehensive so that the score of the achievement test becomes worth. Approximately 22 questions were raised in average through BBS/Chatting for the proposed system while around 19 questions were raised for the existing system so that more frequent Q/A is expected for the proposed system due to the fact that the Q/A of the proposed system can be done in a comprehensive manner rather than the existing system.

4. Concluding Remarks

It is found that mathematical expressions and marks in the view graphs of the e-learning contents during the communications between lecturers and students through BBS/Chatting are effective to improve the achieved score. In the case of the learning of the scientific subject of satellite remote sensing, although 1.3% much longer time is required for the communications, 16.9% of improvement is achieved for the proposed e-learning system by the aforementioned communications.

References

(1)http://www.elc.or.jp/cgi-bin/csvmail/download.htm Shareable Content Object Reference Model

(2) http://jtc1sc36.org/ (Information Technology for Learning, Education and Training)

(3) http://www.adlnet.org/ (Advanced Distributed Learning Initiative)

(4) Mayumi Inokuchi and Kohei Arai, e-learning system with simulation capability for Physics educations, Proceedings of the 29th general conference of the JSiSE: Japanese Society for Information and Systems in Education at Kagawa University, Aug.20-22, 2004.

(5) K.Itoh, M.Yanagisawa, and T.Akahori, Development and evaluation of the system which allows to write onto the Web-based contents, http://www.ak.cradle.titech.ac.jp/Publication/pdf/kiyo/JET2003.pdf

(6) Y.Aoki, F.Ando, A.Nakajima, "Creating Web-based presentations by demonstration", IPSJ Journal, 42, 2, 155-165, 2001.

(7)http://www.cmt.phys.kyushu-u.ac.jp/~M.Sakurai/java/sdoc/mathml/test.html

(8) http://www.parallelgraphics.com/products/cortona

(9) Kohei Arai, e-learning for higher education and global enterprises, Proceedings of the Symposium and JICA Net-Seminar on Developing of National ICT Competencies in Higher Education and Institutions, JICA head office, Aug.23 2004.